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Upper & Lower Baker Dams, Fallon County, Montana, MT-1564, MT-1263

33

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

UPPER & LOWER BAKER DAMS
FALLON COUNTY, MONTANA
MT-1564, MT-1263

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PREPARED FOR:

HONORABLE THOMAS L. JUDGE
GOVERNOR, STATE OF MONTANA

UPPER BAKER DAM
CITY OF BAKER
(OWNER-OPERATOR)

LOWER BAKER DAM
FALLON COUNTY
(OWNER)

PREPARED BY:
SEATTLE DISTRICT, U.S. ARMY CORPS OF ENGINEERS
MARCH 1979

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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

UPPER & LOWER BAKER DAMS
FALLON COUNTY MONTANA

MT-1564
MT-1263

PREPARED FOR:

HONORABLE THOMAS L. JUDGE
GOVERNOR, STATE OF MONTANA

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JUNE 1979

Loren D. Bottorff

LOREN D. BOTTORFF, P.E.

Engineering registration in the State of Montana was applied for on 13 February 1979.

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EXECUTIVE SUMMARY

Personnel of CH2M HILL, under a contract with the Seattle District Corps of Engineers and with representation from the Corps, the State of Montana, the City of Baker, and the U.S. Soil Conservation Service, inspected Upper and Lower Baker Lakes Dams on 7 September 1978, under the authority of Public Law 92-367. The Baker Lake dams are located in Fallon County, Montana, immediately adjacent to the City of Baker. Upper Baker Dam is owned by Fallon County and operated by the City of Baker for flood control and is a sediment retention reservoir. Lower Baker Dam is owned by Fallon County, Montana, and is maintained by the State Highway Department. The lake is used for flood control and recreation.

Both Upper Baker and Lower Baker are embankment type dams, 20 and 17 feet high respectively, located on an unnamed tributary of Sandstone Creek. The drainage area of Upper Baker Dam is 4.69 square miles, maximum reservoir surface area is 240 acres, and the storage at the top of the dam is approximately 3,000 acre-feet. Lower Baker Dam has an additional drainage area of 1.19 square miles (for a combined total of 5.88 square miles), maximum reservoir surface area of 120 acres, and storage of approximately 1,000 acre-feet at the top of the dam.

Upper Baker Dam serves as both a flood control structure and as a sediment trap, which, based on U.S. Soil Conservation Service (SCS) estimates, will provide for 100 years of sediment accumulation. SCS analysis indicates that Upper Baker Dam will completely control the 100-year flood. Lower Baker Dam, was originally constructed by the Chicago, Milwaukee, St. Paul and Pacific Railroad in 1908, and the lake is being dredged to provide greater depth for a fishery and recreational sports. The evaluation of Upper Baker Dam is based on construction control data made available by the SCS (References 2, 3, 4, and 7).

Evaluation of Lower Baker Dam is based solely on the field inspection because no plans or prior data are available. Findings were compared to engineering criteria currently accepted by most large engineering firms and governmental agencies engaged in this type of work.

PRINCIPAL FINDINGS AND EVALUATION

Upper Baker Dam, with storage in excess of 3,000 acre-feet, is in the intermediate size classification of the recommended guidelines (Ref. 1). A sudden failure of Upper Baker Dam would cause Lower Baker Dam to fail, endangering many lives and causing extensive property damage in the City of Baker. Accordingly, the downstream hazard potential is high (Category 1).

Lower Baker Dam, with storage at dam crest of 1,000 acre-feet is also in the intermediate size classification. A sudden failure of Lower Baker Dam would endanger many lives and cause extensive property damage in the City of Baker. The downstream hazard potential of Lower Baker Dam is high (Category 1).

The inspection guidelines require that dams in the intermediate size classification that present a high hazard to the downstream areas must safely handle the full probable maximum flood (PMF). The PMF is defined as a flood expected from the most severe combination of meteorological and hydrological conditions reasonably possible in the region. Spillway capacity of Upper Baker Dam is designed to handle the PMF, as determined by the Soil Conservation Service. However, recomputation and routing of the PMF, using recent updated estimates (Ref. 9) of the probable maximum precipitation (PMP), and by starting the routing at the emergency Spillway elevation, may result in overtopping of the dam. Lower Baker spillway capacity will handle less than 15 percent of the PMF, and as a result, Lower Baker Dam will overtop during floods considerably smaller than the PMF. As the dam is constructed of materials that will quickly erode, it will rapidly fail if overtopped by flood waters. Such failure would endanger the lives of many people and cause extensive property damage. For this reason, Lower Baker Dam is considered unsafe.

The foundation and embankment materials for both dams are residual (weathered in place) clays underlain by clay shale. The foundation for Upper Baker Dam was stripped of loosely consolidated sediments to depths of 5 to 7 feet and a cutoff was carried to shale bedrock. This embankment is zoned with the more impervious clay (highly plastic) upstream, and the clay shale downstream. No form of internal drainage has been provided. Stability analysis by SCS was based on an assumed 6 degree shear angle and 400 pounds per square foot cohesion, and the resulting minimum factor of safety was 1.4. Clay shales are highly susceptible to expansion and loss of strength, and using assumed shear values for stability analysis is not sufficiently conservative for a dam constructed on and with this material. Strength parameters must be determined by special laboratory investigation.

On the basis of the field inspection, and a study of the available boring logs, design records, and analyses, it is our judgment that Upper Baker Dam may not now conform with the inspection guidelines with respect to ~~safety~~ stability of the downstream embankment slope during steady seepage conditions.

Lower Baker Dam has a large width/height ratio, and 70 years of satisfactory service, which together indicate the embankment stability adequately conforms to the recommended guideline (Ref. 1) requirements.

RECOMMENDATIONS

A downstream warning system, for use in the event of possible overtopping should be immediately developed and implemented. Detailed hydrologic and engineering studies must be performed, the PMF for the combined drainages determined, and the project modified to safely handle the PMF. The studies and modifications should include downstream channel capabilities and methods of handling the project flows. Field investigations, including the installation of piezometers, laboratory testing, and engineering studies to determine stability of the Upper Baker dam embankment are required so the embankment can be modified to provide a safety factor of at least 1.75. If for any reason engineering studies and corrective work are delayed or the warning system is not immediately developed and operational, the Lower Baker reservoir should be completely drained and the dam removed.

PERTINENT DATA

GENERAL

State I.D. NO.	343
Federal I.D. NO.	MT-1263 Lower Baker
Owner	Fallon County
Operator	City of Baker
Purpose	Recreation
Location	Sec. 13, T7N, R59E
County, State	Fallon, Montana
Watershed	Sandstone Creek
City	Baker, Montana
Downstream Hazard Potential	Category 1 (High)

SPILLWAY

Type	Ungated Concrete
Width	40 feet
Crest Elevation	2,934.5 feet MSL
Capacity at Dam Crest	1,250 c.f.s.

DAM

Type	Earth Embankment
Crest Elevation	2,940.4 feet MSL
Top Width	30 feet
Length	1,000 feet
Maximum Height	17 feet
Downstream Slope	1 V on 2 H
Upstream Slope to Waterline Elevation	
2,935.5 feet MSL	1 V on 1 H

RESERVOIR

Storage at Spillway Crest	320 acre-feet
Storage at Top of Dam	1,100 acre-feet
Surface Area at Dam Crest	120 acres
Drainage Area	1.19 square miles (Plus Upper Baker Area)

OUTLET WORKS

(None)

PERTINENT DATA

GENERAL

Federal I.D. No.	Mt-1564 Upper Baker
Owner	Fallon County
Operator	City of Baker
Purpose	Flood Control
Location	Section 17, 18, 19, T7N, R60E
County, State	Fallon County, Montana
Watershed	Sandstone Creek
Downstream Hazard Potential	Category 1 (High)

RESERVOIR

Surface Area	240 acres (max), 190 acres (ave)
Storage at Spillway Crest (Elevation 2,951 feet MSL)	1,460 acre-feet
Storage at Dam Crest (Elevation 2,955 feet MSL)	3,000 acre-feet
Surcharge Storage	1,540 acre-feet
Drainage Area	4.69 square miles

SPILLWAYS

Type	Earth
Crest Elevation	2,951 feet MSL
Bottom Width	500 and 100 feet
Capacity	10,000 c.f.s.

OUTLET STRUCTURE

Type	Barrel Orifice
Conduit	48-inch reinforced concrete
Capacity with gate open and water surface at dam crest elevation 2,955 feet MSL	244 c.f.s.

DAM

Crest Elevation	2,955 feet MSL
Type	Earth Embankment
Maximum Height	20 feet
Length	1,540 feet
Crest Width	12 feet
Upstream Slope	1 V on 4 H
Downstream Slope	1 V on 2 H

CHAPTER 1
BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of the Upper and Lower Baker Dams, owned by Fallon County, Montana.

The National Dam Inspection Act, Public Law 92-367 dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-federal dams throughout the United States. Pursuant to that authority, the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" in Appendix D, Volume 1 of the U.S. Army Corps of Engineers' Report to the United States Congress on "National Program of Inspection of Dams" in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists highly experienced in dam safety from many federal and state agencies, professional engineering organizations and private engineering consulting firm. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

The guidelines recommend a two-phased study procedure for investigation and evaluating existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam.
(2) based upon an evaluation of the available data and a visual inspection.
(3) performed to determine if any needed emergency measures and/or if additional studies, investigations and analyses are necessary or warranted.
(4) not intended to include extensive explorations, analyses or to provide detailed alternative correction recommendations.

The details of Phase I recommendations must be developed in Phase II investigation. The Phase II investigation includes

all additional studies necessary to evaluate the safety of the dam and to develop the detailed correction recommendations. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing, material testing, hydraulics and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The Corps has no authority to enforce the recommendations contained in the safety reports. The responsibility for implementation of the Phase I recommendations or initiating the Phase II studies rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and no action or failure to act under this act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-Federal interests.

1.1.3 Inspection

The findings and recommendations in this report were based on visual inspection of the project, a review of available plans and specifications, and design analyses. Inspection procedures and criteria were those established by the Recommended Guidelines for Safety Inspection of Dams (Ref. 1).

Personnel present during the inspection included:

Louis Boitano, Civil Engineer, Corps of Engineers
Robert Clark, Agricultural Engineer, State of Montana, Department
of Natural Resources and Conservation
Wesley Dent, Lake Foreman, City of Baker
Tom Eggensperger, Fallon County Planner
John Dalton, U.S. Soil Conservation Service
Louis Jensen, U.S. Soil Conservation Service
Ken Pfeiffer, U.S. Soil Conservation Service

CH2M HILL personnel who participated in the field inspection and who contributed to this report are:

Miles Bubenik, Geotechnical Engineer, Team Leader
Loren Bottorff, Hydrologist/Hydraulics Engineer

1.2 DESCRIPTION OF PROJECT

1.2.1 General

Upper Baker Dam is an earth embankment located in Sections 17, 18, and 19, Township 7 North, Range 60 East, on Sandstone Creek, Fallon County, Montana. Although this dam is not listed at present, it will be included in the National Dam Inventory as Upper Baker Dam (MT-1564). Lower Baker Dam is also an earth embankment, located in Section 13, Township 7 North, Range 59 East, on Sandstone Creek, Fallon County, Montana. The National Dam Inventory designates Lower Baker Dam as MT-1263. Both dams have a high, or Category 1, downstream hazard potential in case of failure. Upper Baker Dam is owned by Fallon County and operated by the City of Baker, and serves as a sediment retention reservoir and for flood control. Lower Baker Dam is owned by Fallon County and serves both for flood control and recreation.

1.2.2 Regional Geology and Seismicity

The Baker watershed is in the northern portion of the Great Plains Province near the center of a conspicuous folded structure known as the Cedar Creek anticline. The uplift and folding of the structure and the subsequent erosion, which has planed the surface comparatively level, has resulted in the exposure of a narrow strip of the Pierre Shale along the center of the anticline. Around the area of shale is a relatively narrow band of sandstone ridges that rise 100 feet or more above the shale surface. Dip of the strata on the west side of the anticline ranges from 5 to 30 degrees, while on the east side, dips range from 2 to 5 degrees. Cretaceous-aged bedrock of the Pierre Shale formation characterizes the surface geology of the watershed. The Pierre consists of dark green to dark brown shale, which weathers to dark heavy plastic clay. The shale itself is soft and thinly bedded so that its structure is hard to determine.

Outcrops contain bentonite concretions as large as one foot in diameter, large boulders of sandstone, and gypsum veins and crystals. The shale in the upper part of the formation is relatively impervious. The topography is flat to slightly rolling.

In accordance with the recommended guidelines (Ref. 1), both Upper and Lower Baker Dams are in Seismic Zone 1. Damage associated with Zone 1 is minor.

1.2.3 Design and Construction History

Upper Baker Dam, constructed by the SCS, was first operated in 1975. SCS has complete foundation investigation, design, and construction control records, which were made available for this review. Lower Baker Dam was constructed in 1908 by the Chicago, Milwaukee, St. Paul and Pacific Railroad. There is no record of design or construction history.

CHAPTER 2
INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Spillways

Upper Baker Lake has two emergency spillways (Photo 4) excavated 4 feet below the top of the embankment into the natural ground adjacent the left and right abutments. The left abutment spillway is 500 feet wide, and the right abutment spillway is 100 feet wide. The combined spillway capacity at the point of embankment overtopping, elevation 2,955 feet MSL, is about 10,000 cubic feet per second (c.f.s.) (see Plate 5). The emergency spillways are designed to operate once in every 100 years, are sodded, and appear to be in very good condition.

Lower Baker Lake spillway is located adjacent to the left abutment and south of the dam. The concrete overflow spillway crest is 40 feet wide and is 5.9 feet below the low point of the dam embankment. The approach channel to the spillway passes under the highway bridge for Montana State Highway Number 7, which continues on across the crest of the dam. The approach channel elevation is above the spillway crest for its total length and contains brush, which will reduce the discharge capacity. The channel is temporarily blocked by earth that was placed to allow higher lake levels for dredging operations now in progress. The estimated discharge capacity of the spillway with the lake at the point of embankment overtopping is about 1,260 c.f.s. (see Plate 6). The spillway concrete is in poor condition and discharges are undercutting the spillway toe (Photo 4).

2.1.2 Outlet Works and Service Spillway

Outlet works for Upper Baker Lake are located near the left abutment of the dam, as shown in Photo 2. The outlet structure is equipped with a 4 x 4 foot slide gate controlled by a hydraulic cylinder. A 4-foot concrete pipe extends through the embankment to an impact type energy dissipator downstream (see Plate 4). Maximum discharge capacity of the outlet works with the gates fully open is about 250 c.f.s. The outlet structure will act as a decant tower when the gate is closed. The tower is equipped with two 5-foot-long weirs and two 1.1-square-foot orifices. The flow from the weirs and orifices passes through another, 2-square-foot,

orifice before entering a discharge pipe. This system, with the gate closed, can handle approximately 36 c.f.s. at high lake levels. Trashracks are provided for the weirs and orifices. The outlet works appeared in very good condition.

Lower Baker Lake has no low-level outlet and cannot be drained. The spillway is the only means of handling water.

2.1.3 Freeboard

Freeboard at Upper Baker Dam at the time of the inspection was 13.4 feet. A high water mark was measured about 8 feet below the dam crest. Design freeboard above the principal spillway is 7.4 feet. Freeboard above the emergency spillway is 4 feet.

The freeboard at Lower Baker Dam at the time of the inspection was 4.8 feet. The low point of the dam crest (State Highway 7) is 5.9 feet above the spillway crest. A section of road about 1,000 feet south of the spillway is about 5 feet above the spillway crest. This section of road has overtopped during large floods.

2.2 HYDROLOGY

2.2.1 Physiography and Climatology

The drainage area for Upper Baker Lake is 4.69 square miles and the basin consists of gently rolling grasslands with an elevation difference between the top of the principal spillway and the drainage divide of only 100 feet. Elevations in the watershed range from 2,900 to 3,050 feet MSL. The climate of the area is semiarid with average annual rainfall at Baker of only 13.7 inches for the period 1925 to 1967. Precipitation varies from 2 percent of the annual total in December to 25 percent of the annual total in June. Approximately 80 percent of the annual precipitation falls in the period April through September. Average annual temperature is about 44 degrees F with extremes varying from about 104 degrees F to -36 degrees F. The average frost-free period is 127 days.

2.2.2 Estimated Probable Maximum Flood

The probable maximum flood (PMF) is the flood expected from the most severe combination of critical meteorological and hydrological conditions that are reasonably possible in the region.

The U.S. Soil Conservation Service made an estimate of the PMF while designing Upper Baker Dam. The SCS refers to this flood as the Freeboard Hydrograph. The SCS used the U.S.

Weather Bureau's Technical Paper 38 (Ref. 6) to obtain the probable maximum precipitation (PMP) for the drainage area. Technical Paper 38 provides PMP estimates west of the 105th meridian. The Baker drainage basin is actually east of the 105th meridian, but it is close enough (104° 15') that estimates could be made. The 6-hour PMP is 18.6 inches.

The SCS used Section 4, "Hydrology," of their National Engineering Handbook (Ref. 7) to obtain the Freeboard Hydrograph from the PMP and basin characteristics. A step-by-step procedure for development of the Freeboard Hydrograph is outlined in Chapter 21 of this publication. The SCS used a travel time of 2 feet per second to obtain a time of concentration of 2.6 hours. They used a runoff curve number (CN) of 84 to obtain a net runoff of 16.5 inches, or 4,130 acre-feet. The SCS Freeboard Hydrograph has a peak inflow to the reservoir of 12,766 c.f.s. The routing was started at principal spillway elevation 2,947.6 feet MSL, which is 3.4 feet below the emergency spillway. The maximum routed outflow from the reservoir is 8,684 c.f.s.; a freeboard of 0.4 feet remains. Based on the SCS analysis, Upper Baker Dam can safely handle the PMF.

The SCS procedure does not develop a storm pattern to apply directly to a unit hydrograph with losses. The procedure uses the total rainfall and CN to determine the family of standard dimensionless unit hydrographs to be used with the total net runoff. The peak flow and the time to peak are then used with the appropriate dimensionless unit hydrograph to obtain the Freeboard Hydrograph.

The U.S. Weather Bureau's Hydrometeorological Report No. 33 (Ref. 8) provides PMP estimates east of the 105th meridian, the location of the Baker drainage basin. The 6-hour PMP value from this publication agrees with the 6-hour PMP value from Technical Paper 38 (Ref. 6) that the SCS used. However, Hydrometeorological Report No. 51 (Ref. 9), pubished in June 1978, provides updated estimates of the PMP east of the 105th meridian: the 6-hour PMP is estimated to be 20.5 inches, about 10 percent higher than the 1956 and 1960 estimates (Ref. 6 and 8). This change in precipitation will increase the flood peak and volume by approximately 10 percent.

The 2 feet per second used by the SCS to estimate time of concentration may be slow. A shorter time of concentration and resultant time to peak, will produce a higher and earlier peak. The inflow hydrograph shape would be changed, but significant changes in the routed hydrograph would probably not occur. Beginning the routing of the flood 3.4 feet below the emergency spillway is contrary to conservative policy in routing a PMF. A flood with a volume of 18 percent of the PMF could fill the reservoir to the

emergency spillway on the day before the PMF. The service spillway would not be able to significantly lower the reservoir if the PMF occurred on the following day. Approximately 750 acre-feet of the storage used in the SCS routing would not be available if the PMF were started with the reservoir at the emergency spillway crest.

During the SCS routing of their Freeboard Flood, approximately 0.4 feet of freeboard on the dam remained at the time of peak outflow. This would probably not be adequate to handle the increased flood resulting from the precipitation that was estimated in Hydrometeorolgical Report No. 51 (Ref. 9), with routing beginning at emergency spillway crest. Even though it appears that the dam could be overtopped under these conditions, routing studies are required since the dam is very close to being able to handle the PMF. Just before overtopping occurs, the dam will be passing over 10,000 c.f.s. downstream.

The PMF for Lower Baker Dam will have a volume of about 5,800 acre-feet. Approximately 630 acre-feet of storage is available in the reservoir between the spillway crest and the top of the dam. The spillway will pass very little of this flood before overtopping occurs. By comparing flood volume with storage volume, it appears that Lower Baker Dam will overtop during the PMF when less than 15 percent of the flood volume enters the reservoir.

2.3 GEOTECHNICAL EVALUATION

The Soil Conservation Service carried out an extensive exploration program that included borings and surficial mapping of the Upper Baker dam and reservoir area. Logs of borings were included in the contract plans for embankment, spillway area, and the borrow areas. These data were considered in our evaluation of the project.

2.3.1 Dam Embankments

Upper Baker

Upper Baker Dam is 20 feet high, 1,540 feet long, and has a crest width of 12 feet. The upstream slope is 1 V (vertical) on 4 H (horizontal) and the downstream slope is 1 V on 2 H. The embankment is zoned and the cutoff trench was carried to shale bedrock, as shown on Plate 4.

The damsite prior to construction is described as consisting of saturated clayey alluvial fill underlain at shallow depths by sediments of the Cretaceous-aged Pierre Shale Formation. The abutments are composed of consolidated, residual (weathered in place) clay underlain by the shale. Shale in the upper part of the formation is relatively impervious.

The loosely consolidated sediments that occur throughout the foundation at depths ranging from 5 to 7 feet were removed by the construction. Impervious borrow materials, consisting of clays, silty clays, and silty sands which classify as CH and SM under the Unified Soil Classification System, were obtained from a small upland bench downstream of the left abutment. Shale borrow material was obtained from the emergency spillway excavation at both the left and right abutments. Materials consisted of weathered shale, which classifies as a CH clay. The clays were utilized in the Zone 1 portion of the embankment, and the softer shale in Zones 2 and 3. As expected, some of the more decomposed shales disintegrated during excavation and placement in the structure.

The upstream embankment slope is protected from erosion caused by wave action by a variable thickness of the harder shales, as shown on Plate 4.

Lower Baker

Lower Baker Dam is a 1,000-foot-long earth embankment with a maximum height of 17 feet, a downstream slope of 1 V on 2 H, an unknown upstream slope, and a crest width of 30 feet. Foundation and embankment soils are believed to be similar to those at Upper Baker. The upstream slope shows evidence of considerable erosion and is sparsely protected with rock riprap.

2.3.2 Foundation Conditions, Seepage, and Drainage

Upper Baker

The foundation of Upper Baker Dam (Plate 2) is shale bedrock, which is relatively impervious. The field inspection of toe areas found no evidence of seepage. There are no piezometers installed in the embankment.

Lower Baker

Lower Baker Dam foundation materials are believed to be predominantly impervious clays and sandy clays similar to those of Upper Baker. The field inspection found no evidence of seepage throughout the entire toe area. There are no piezometers installed at Lower Baker Dam.

2.3.3 Stability

Upper Baker

The embankment for Upper Baker Dam was designed by the Soil Conservation Service. Their stability analysis, based

on an assumed 6 degree shear angle and 400 pounds per square foot cohesion, resulted in a minimum computed safety factor of 1.4.

Clay shales, such as those containing bentonite or montmorillonite found in this area, may be susceptible to expansion, contraction, and severe loss of strength especially over long periods of time and in the presence of water. Foundations consisting of clay shales require special measures in strength and stability investigations and often require special treatment during construction. The 1 V on 2 H downstream slope is not a conservative design for clay shale embankment materials, considering that no form of internal drainage has been provided. The 1 V on 4 H upstream slope may have adequate safety.

Lower Baker

Lower Baker Dam has functioned satisfactorily since its construction in 1908, with no reported instability or seepage problems. It has a relatively large width/height ratio, and can be considered stable with respect to slope failure. However, the stability should be confirmed by the installation of piezometers in the embankment section along with sampling testing and stability analyses.

2.4 PROJECT OPERATION AND MAINTENANCE

2.4.1 Dam and Reservoir

An Operations and Maintenance Agreement (Ref. 5) between the City of Baker and the Soil Conservation Service was signed on 19 June 1974, and in 1975 the City began operation of Upper Baker Reservoir for purposes of flood control and sediment storage. Baker, the project sponsor, agreed to operate and maintain the project in a manner that would assure that the structures serve the purpose for which they were installed, in accordance with the following:

1. On 1 April each year, the drawdown gate shall be operated at least one complete cycle through its full operating range and then left completely closed to entrap sediments.

2. When sediment has settled, the gates shall be partially opened to release stored waters to maintain the desired level in Baker Lake. The rate of discharge shall be regulated to prevent adverse erosion downstream.

3. The gate shall be completely closed during storm runoff periods to gain as much sediment and trapment as possible, and then again partially opened after settlement has taken place.

4. Upon request from the pipeline companies, the gates shall immediately be fully opened to provide emergency withdrawal of waters from the reservoir area.

5. On September 30 each year, the gates shall again be operated at least one complete cycle to full operating range and then left fully open until the following April 1.

Paragraph B requires the sponsor to prohibit recreational use of the sediment pools (i.e., motorboating) that will agitate the sediment and settling process.

Paragraph D provides for a checklist of items to be inspected by the City that includes the principal spillway, emergency spillways, the reservoir area, and the condition of the embankment. The agreement further provides that the City shall remove and dispose of debris, repair and replace the upstream gravel slope protection and maintain records of all performance.

Lower Baker Dam is maintained by the Montana State Highway Department; however, maintenance appears to have been minimal, as the spillway toe area has been undermined by flow over the spillway. The spillway approach channel is blocked by earth and debris, and the reservoir slope shows evidence of erosion. As there is no low level outlet, all flows must pass over the spillway. There are no staff gauges or records of present operation at either Upper Baker or Lower Baker Dams.

2.4.2 Warning System

There is no formal warning system or plan of action to warn downstream inhabitants in the event of dam distress.

2.5 POTENTIAL FOR DOWNSTREAM DAMAGE

Upper Baker Dam is located in a wide flat valley. There is no known development downstream of Upper Baker Dam in the 1,000 feet betweem the dam and Lower Baker Lake. Lower Baker Lake is within the City of Baker, several residences line its shore, and there are many residences downstream of the lake. The discharge from Lower Baker Dam enters Sandstone Creek about 0.7 miles downstream of the dam. The exact nature of downstream development that might be affected by a dam failure is beyond the scope of this report to analyze.

The spillway and reservoir capacity of Upper Baker Dam have been designed to handle PMF, as determined by the Soil Conservation Service. This flood may be too small, as

described in paragraph 2.2.2, and the PMF may actually overtop the dam. However, 10,000 c.f.s. will be passing the dam at the time of overtopping and we believe failure of the dam under this flow will cause little increased downstream damages over that already occuring. Also, Upper Baker Dam may not now conform to inspection guidelines with respect to safety of the downstream embankment slope during steady state seepage conditions.

Minor flooding occurs almost annually to residences on the shore of Lower Baker Lake. Just prior to overtopping of Lower Baker Dam, several residences surrounding the lake and several residences downstream of the dam will be flooded. Lower Baker Dam will overtop during the PMF when less than 15 percent of the total flood volume enters the reservoir. This means the dam will overtop during floods considerably smaller than the PMF. The dam is constructed of materials that would rapidly erode if overtopped by flood waters. Such a failure of Lower Baker Dam would endanger many lives and cause additional property damage to the occurring prior to overtopping.

Given the present inadequate discharge and reservoir storage capacities, Lower Baker Dam is unsafe.

CHAPTER 3
FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

On the basis of visual inspection of Upper and Lower Baker Dams, supplemented by design and construction data on Upper Baker Dam, and in accordance with performance standards of the recommended guidelines (Ref. 1), the evaluation resulted in the following findings:

3.1.1 Size and Hazard Potential

Upper Baker Dam

This 20-foot-high earth embankment dam impounds 1,460 acre-feet at spillway crest elevation and approximately 3,000 acre-feet at the top of the dam. The sudden or rapid failure of Upper Baker Dam would endanger many lives and cause extensive property damage in the City of Baker immediately downstream. On the basis of this information and in accordance with the recommended guidelines (Ref. 1), the project size is intermediate and the downstream hazard potential is high.

Lower Baker Dam

This 17-foot-high earth dam impounds 320 acre-feet at spillway crest and 1,000 acre-feet at the dam crest. The current National Dam Register lists Lower Baker Dam as having high downstream hazard potential in case of failure. The sudden breach of Lower Baker Dam would endanger many lives and cause extensive property damage to Fallon County roads, a state highway, and commercial and private property in the City of Baker. On the basis of this information and in accordance with the recommended guidelines (Ref. 1), the project size is intermediate, and the downstream hazard potential remains high.

3.1.2 Embankment Dams

Upper Baker Dam

A visual inspection showed that the downstream embankment slopes and crest were uniform and conformed to slopes established by the design. An examination of the downstream toe indicated no wet areas or seepage. The embankment

section is zoned with the clays upstream and the less weathered clay shales downstream. The dam does not have an internal drainage system. The downstream embankment slope contains an octagonal pattern of shrinkage cracking, 2-to 2-1/2 inches wide and perhaps 2- to 3-feet deep, which is typical of many Montana clays. Neither the upstream slope nor the crest exhibited the cracking noted on the downstream slope because the clayey material was covered with aggregate.

The minimum safety factor computed by SCS for stability of this downstream slope is 1.40. The analysis was based on assumed shear strength values for the clay shale embankment and foundation soils. The clay shales, particularly those containing bentonite or montmorillonite, may be susceptible to expansion, contraction, and severe loss of strength. The use of assumed shear strength values for stability analyses is not sufficiently conservative for a dam constructed of clay shale materials on a clay shale foundation.

Lower Baker Dam

No information on the foundation investigation, design, or plans and specifications was available for review. A visual inspection of the dam (which carries Montana State Highway Number 7, a paved roadway) showed no irregularities nor serious cracking in the roadway surfacing. An examination of the toe area indicated no evidence of wet areas or seepage. A few large trees were growing on the upstream slope, and there was evidence of minor erosion.

Because of the relatively large width and low height of Lower Baker Dam, and because of the long history of satisfactory performance, slope stability is not considered a problem. However, this should be confirmed by installation and monitoring of a few piezometers in the embankment, along with sampling, testing and stability analyses.

3.1.3 Spillway and Reservoir Capacity

Upper Baker Dam

The probable maximum flood (PMF) for the 4.69-square-mile drainage area has been computed by the Soil Conservation Service, and the spillways, on either side of the dam embankment, have been sized by the SCS to pass the PMF without overtopping the dam. This report raises a question of whether the PMF can safely pass without overtopping the dam.

Lower Baker Dam

The PMF for the 5.88-square-mile drainage area (of which 1.19 square miles is drainage area for the Lower Baker

reservoir) will have a peak flow in excess of 9,500 c.f.s. based on extrapolation of the Soil Conservation Service computations for the probable maximum flood in Upper Baker reservoir. Existing spillway capacity at dam crest is not more than 1,200 c.f.s. The combination of reservoir capacity and spillway discharge is insufficient to prevent dam overtopping during the PMF. Inspection guidelines (Ref. 1) require that the Lower Baker spillway capacity and/or storage safely handle the probable maximum flood for its size and hazard classification.

3.1.4 Safety Evaluation

Because Lower Baker Dam has inadequate spillway and/or storage capacity to safely handle the estimated PMF, overtopping of Lower Baker Dam would occur and cause rapid failure. Such failure would ~~endanger~~ endanger many lives and property. In its present condition, Lower Baker Dam is considered unsafe.

Upper Baker Dam may not conform to guidelines with respect to spillway capacity to handle the PMF or stability of the downstream slope.

3.1.5 Outlet Works

Upper Baker Dam

The outlet works seen in Photo 2, also referred to as the principal or service spillway, appeared in excellent condition.

Lower Baker Dam

There is no low-level outlet at Lower Baker Dam.

3.1.6 Operation and Maintenance

Upper Baker Dam

Upper Baker Dam is owned by Fallon County and operated by the City of Baker.

The Soil Conservation Service developed an operations and maintenance agreement (Ref. 5) with the City of Baker that is discussed in paragraph 2.4, Project Operation and Maintenance.

The agreement provides for a checklist of items to be inspected by the City that includes the principal spillway, emergency spillways, the reservoir area, and the condition of the embankment. The agreement further provides that the City shall remove and dispose of debris, repair and replace the gravel embankment on the upstream slope, and maintain records of all performance.

Lower Baker Dam

Lower Baker Dam is owned by Fallon County and maintained by the Montana State Highway Department.

There is no formal operations and maintenance manual. Maintenance appears to be provided on an "as-needed" basis.

3.2 RECOMMENDATIONS

Upper Baker Dam

1. Re-examine embankment stability using shear strength data obtained from appropriate special laboratory test results, and using measurement piezometric levels from observation wells; modify the embankment as required to provide for a safety factor of at least 1.75.

2. Prepare and implement a formal operation and maintenance manual.

Lower Baker Dam

1. Immediately develop and implement an emergency warning plan for use in the event of dam overtopping.

2. Repair the undercut section of the spillway.

3. Remove trees growing on upstream slope and using suitable backfill, repair holes left by removal of stumps and roots.

4. Remove the earth berm obstructing the spillway approach channel.

5. Install piezometers in the dam, and evaluate the phreatic surface and its effect on embankment stability.

6. Conduct an engineering study to determine the probable maximum flood (PMF), and modify the project to safely handle the full PMF. The PMF study should include an independent check of the SCS Upper Baker flood study and an assessment of downstream channel capacity and possible methods of handling the projected flows.

7. Should the engineering studies and the required modifications be delayed or impossible to accomplish, the lower dam should be removed.

8. Periodic inspections of both dams should be conducted at 5-year intervals by engineers with experience in dam design and construction.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C., Department of the Army, May 1975.

2. Soil Conservation Service, "Watershed Work Plan, Baker Lake," Washington, D.C., U.S. Department of Agriculture, August 1972.

3. Soil Conservation Service, "Detailed Geologic Investigations, Baker Lake Dam Site," Washington, D.C., U.S. Department of Agriculture, May 21, 1974.

4. Soil Conservation Service, As-Built Construction Plan for Upper Baker Lake, U.S. Department of Agriculture, 1975.

5. City of Baker, Montana, Operation and Maintenance Agreement for Structural Measures, June 19, 1974.

6. U.S. Weather Bureau, Technical Paper No. 38, "Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian," Washington, D.C., U.S. Department of Commerce, 1960.

7. Soil Conservation Service, SCS National Engineering Handbook, Sec. 4, "Hydrology," U.S. Department of Agriculture.

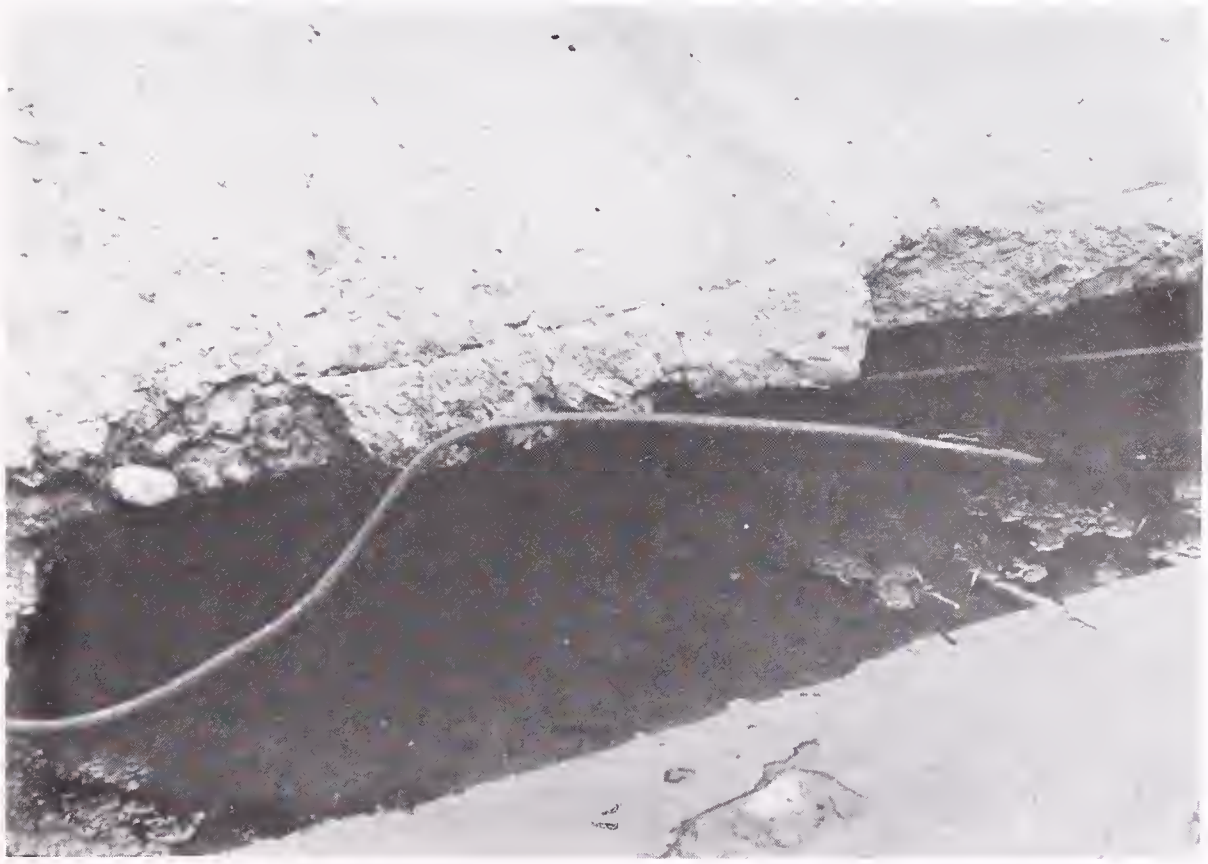
8. U.S. Weather Bureau, Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Washington, D.C., U.S. Department of Commerce, April 1956.

9. National Weather Service, Hydrometeorological Report No. 51, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Washington, D.C., U.S. Department of Commerce, June 1978.

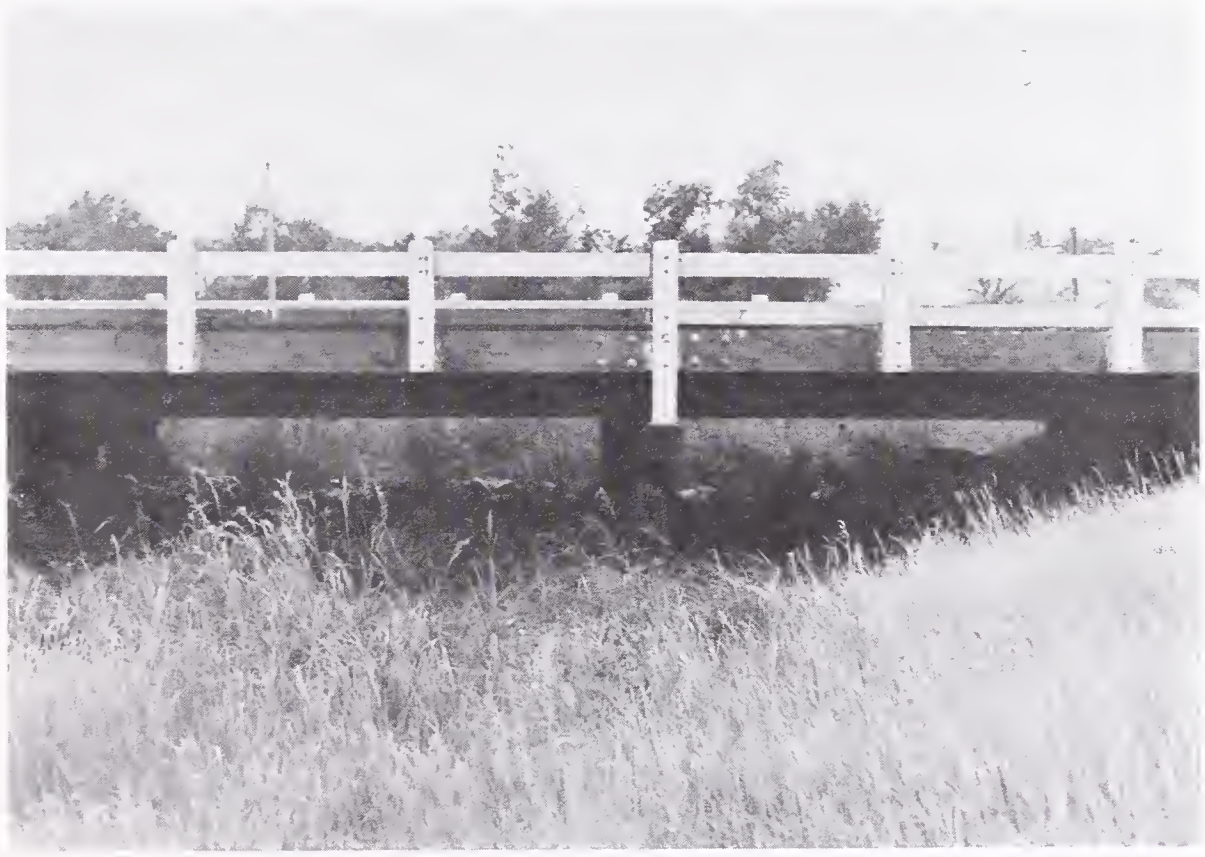
[PHOTO 1] Lower Baker Lake Dam

[PHOTO 2] Lower Baker Lake; Approach Channel to Spillway Blocked by Earth Placed to Keep Lake High for Dredging

[PHOTO 3] Lower Baker Lake; Spillway; Lake is Behind Highway Bridge



[PHOTO 4] Lower Baker Lake; Toe of Spillway



[PHOTO 5] Lower Baker Lake; Spillway Channel
(spillway on upstream side of bridge)

[PHOTO 1] Upper Baker Flood Control Dam; Outlet Structure and Embankment Looking East

[PHOTO 2] Upper Baker Flood Control Dam; Outlet Structure

[PHOTO 3] Upper Baker Flood Control Dam; Downstream Slope

[PHOTO 4] Upper Baker Flood Control Dam; 500 ft Wide Emergency Sod-Lined Spillway Near Left Abutment of Dam (looking towards Baker)

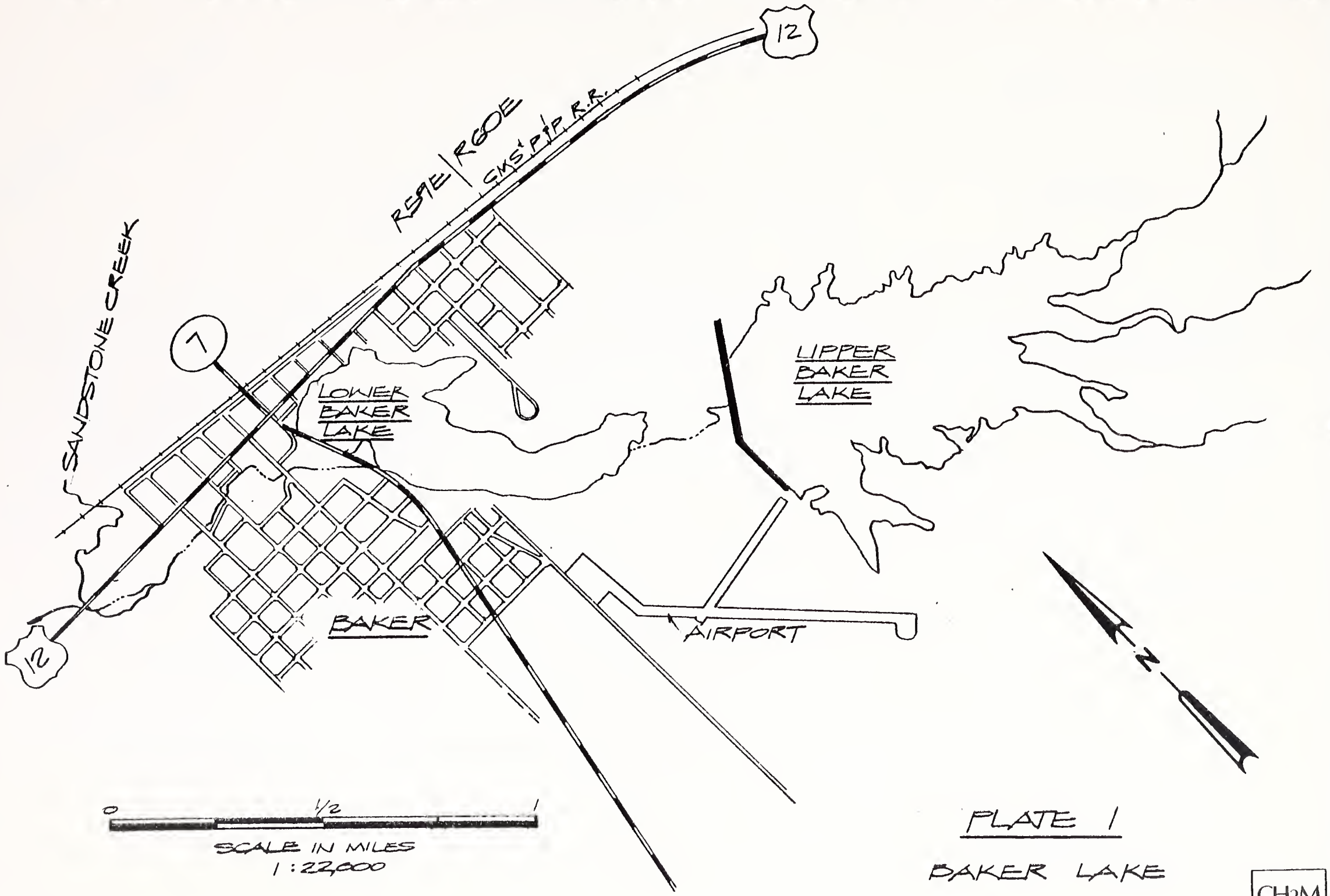


PLATE 1

BAKER LAKE

LOCATION MAP

CH2M HILL

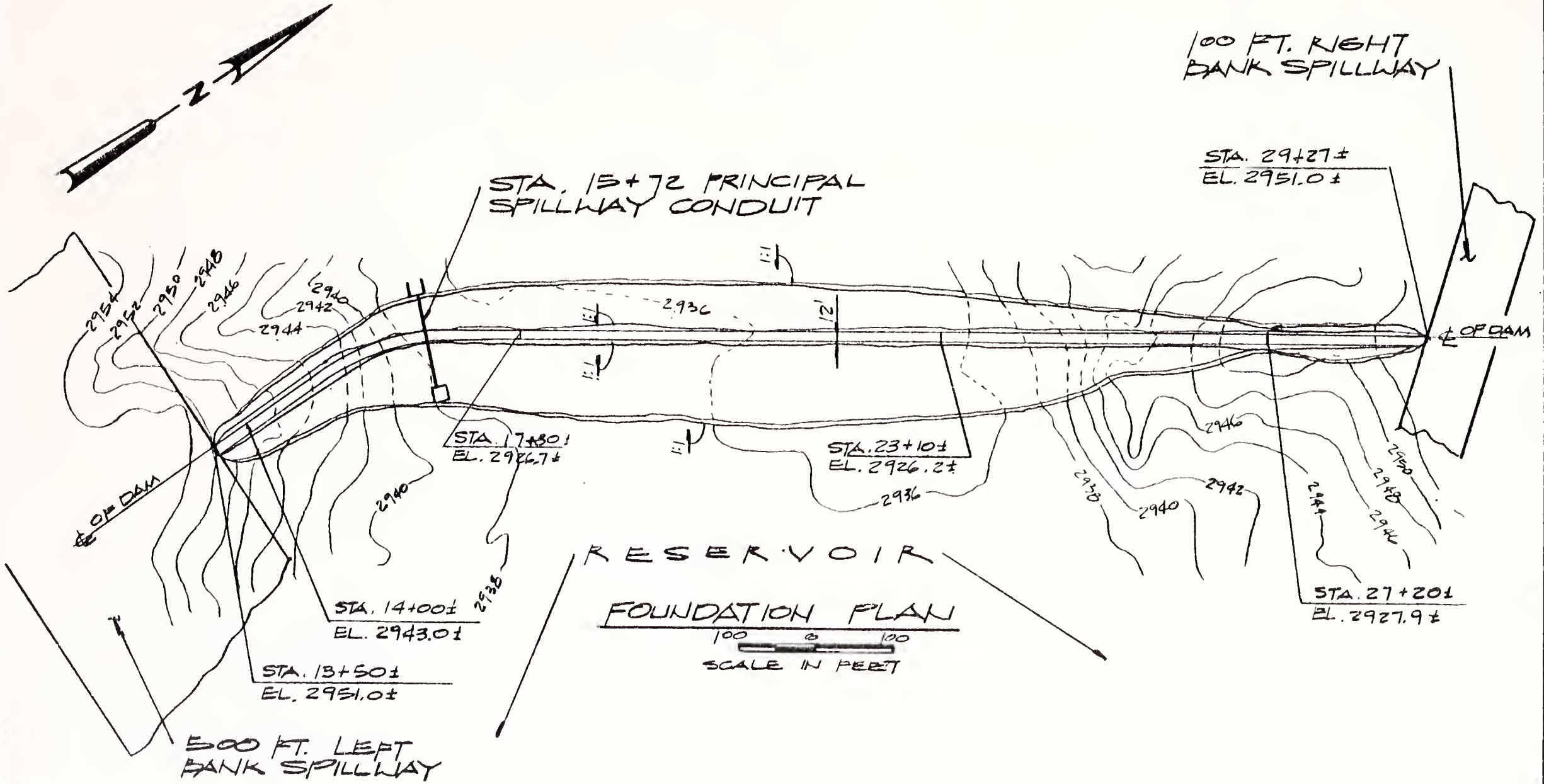
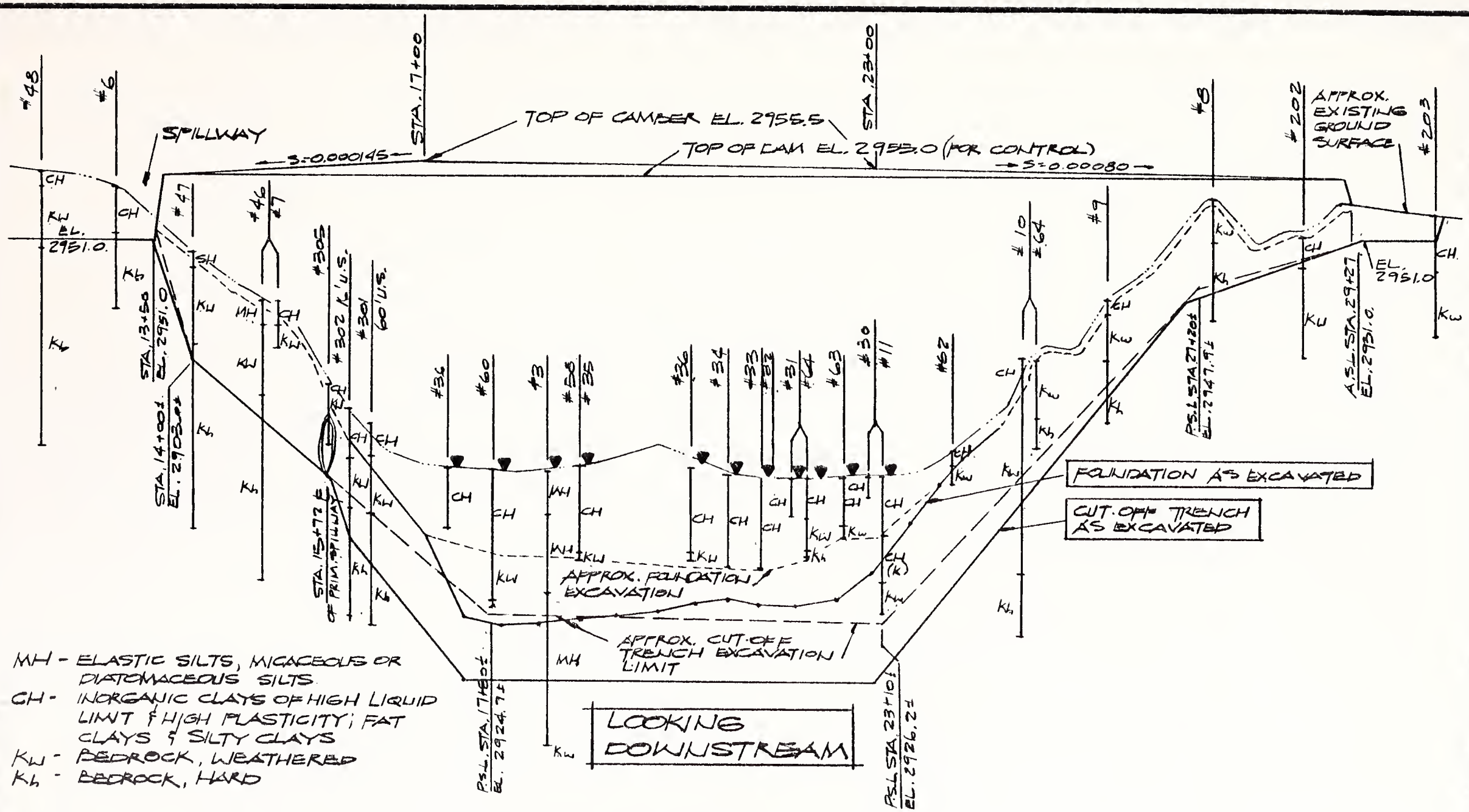


PLATE 2

BAKER DAM
-UPPER-

- PLAN -

CH2M HILL

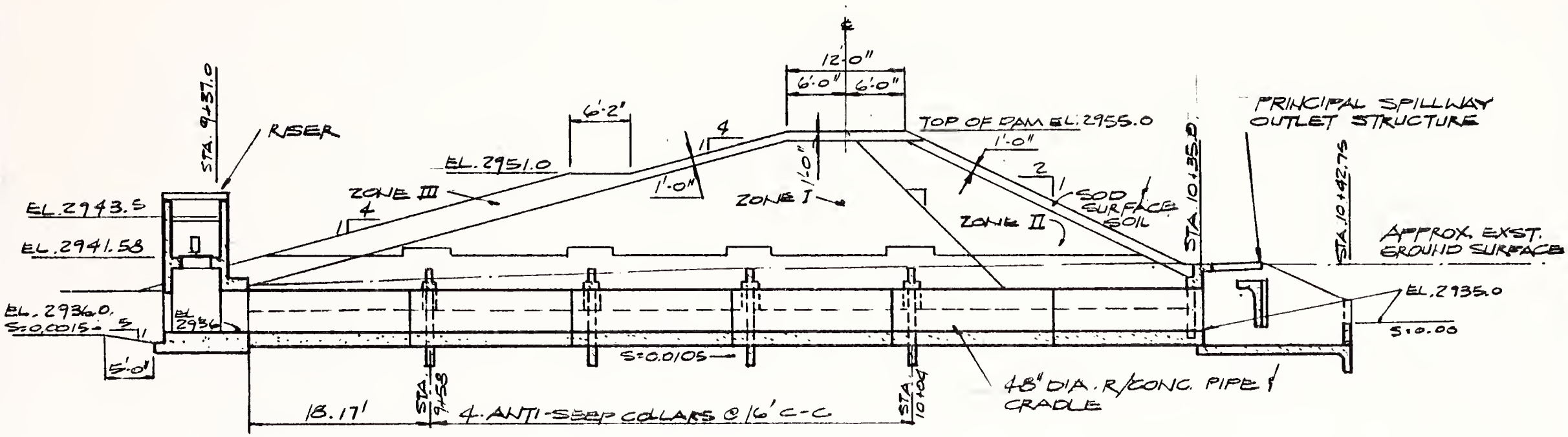


PROFILE ALONG ℄ OF DAM

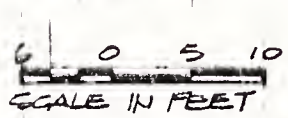
PLATE 3

BAKER DAM
- UPPER -
PROFILE

CH2M HILL



PROFILE ALONG CENTERLINE



ZONE	MATERIAL
I	CLAYS
II	SOFT SHALES
III	HARDER SHALES

PLATE 4

BAKER DAM
-UPPER-

PROFILE OF PRINCIPAL SPILLWAY

CH2M HILL

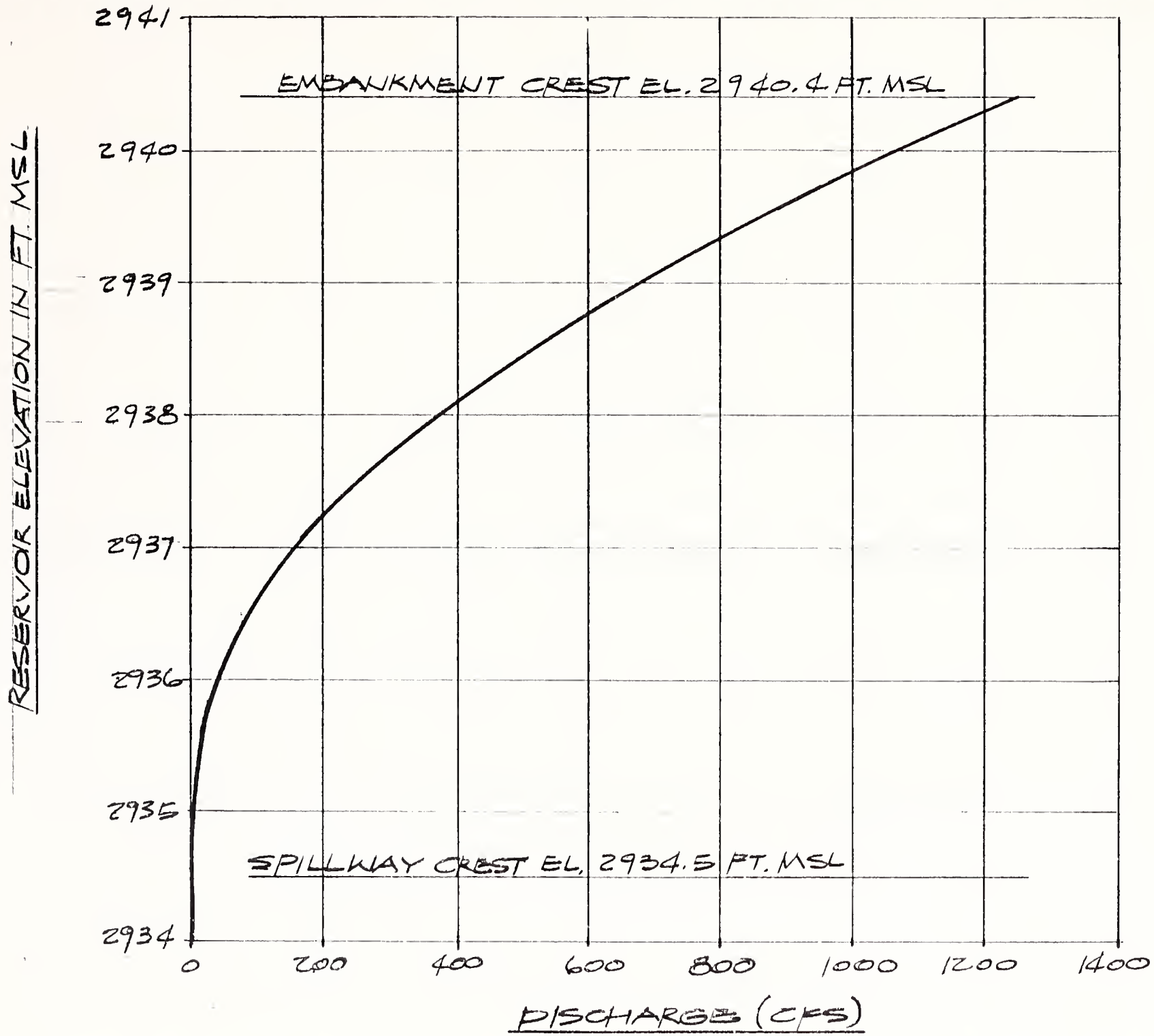


PLATE 5

LOWER BAKER DAM

SPILLWAY RATING CURVE

CH2M HILL

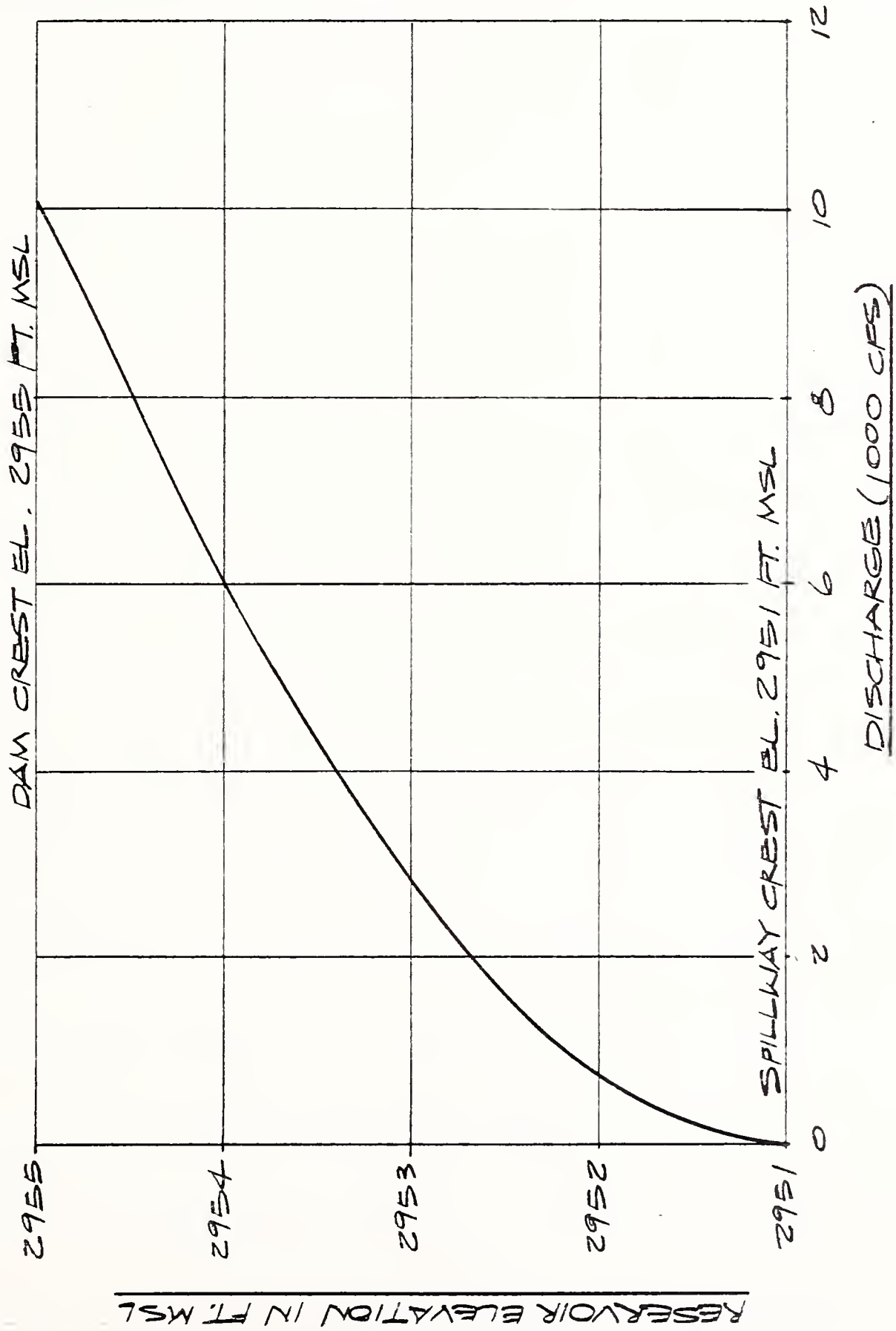


PLATE 6

UPPER BAKER DAM
EMERGENCY SPILLWAY
DISCHARGE-RATING CURVE

CH2M HILL

DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
WATER RESOURCES DIVISION

32 SOUTH EWING
HELENA, MT 59601
406-449-2864

THOMAS L. JUDGE, GOVERNOR
TED J. DONEY, DIRECTOR

May 14, 1979

Mr. Ralph Morrison
Department of the Army
Seattle District - Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Morrison:

The Department of Natural Resources and Conservation has reviewed the inspection report for Upper and Lower Baker dams. Our review comments are listed below.

A. In the executive summary, second paragraph, only approximate maximum storage capacity is listed. It would be helpful to also list the normal operating capacities.

B. On Page IV, last paragraph on the page, Upper Baker Lake has storage in excess of 3,000 A.F., but on Page III, the storage capacity is approximately 3,000 A.F. On Page V, in the same paragraph, Lower Baker Lake has 1,000 A.F. storage when before it was approximate. It would be less confusing to the reader if the same descriptive terms relating to capacity were used throughout the report.

C. On Page V, second paragraph, Lower Baker Dam overtops at less than 15% of the PMF. Is part of the 15% of the PMF for South Baker Lake routed flows from Upper Baker Lake? Also, what effects will routing the PMF through Upper Baker Lake have on the routing of the PMF through Lower Baker Lake?

D. Recommendations, Page VII, what should the factor of safety be for the bank stability?

E. Listed below are comments on the Pertinent Data Sheets for both reservoirs.

1) The spillway capacity of Lower Baker Dam, Page VIII.
2) Is there a mistake regarding the upstream slope and elevation of waterline shown on Page IX?
3) Is the surface area shown on Page IX under Reservoir at the top of the dam?

4) Is the spillway the only outlet works for Lower Baker Lake?
5) On Page X, it would be helpful to list storage at top of dam for Upper Baker Lake as was done with Lower Baker Lake.
6) For each dam, will the rating curves be developed for the outlet works and the spillways?

G. Background

1) Page 2 - Robert Clark is an Agricultural Engineer, not a Civil Engineer.
2) Who is the structural engineer?
3) Who is the registered Montana PE?

H. Paragraph 2.1.1 Spillways, paragraph 2. Does the highway bridge located below the Lower Baker Dam restrict the outflow? Where is the control section for the spillway located?

I. On Page 10, paragraph 2, it states that the spillway on Upper Baker Dam can pass the PMF. What effect will prolonged flows have on the earthen spillway, and will the velocities be low enough to prevent the earthen spillway from washing out?

J. On Page 13, under 2.3.1. Dam Embankments, Upper Baker, is the dam riprapped? If so what condition is it in? Also, is Lower Baker Dam riprapped?

K. The operating instructions provided by the SCS, paragraph 3, Page 17, recommends closing the gate during storm runoff periods. Would a recommendation to open up the gates be of any help in routing larger inflows during storms through the reservoirs?

L. On Page 18, paragraph 3, talks about gravel on the upstream slope, is this riprap?

M. On Page 21, paragraph 1, Lower Baker Dam. Shouldn't the first sentence read "...spillway crest and approximately 1,000 acre-feet..."?

N. On Page 25, 3.1.6 O&M Lower Baker Lake. Do you feel the "as-needed" maintenance is adequate?

O. Under recommendations Paragraph 3.2. No recommendation is made to repair the Lower Baker Dam spillway. On Page 7 the spillway condition is discussed and picture #4 shows the poor condition of the spillway toe.

P. Page 29, Photo #1. Shouldn't the rip rap be mentioned? Should the photos have individual numbers rather than doubling up some of the numbers?

We would like to thank you for the opportunity to review and offer our comments on the Baker Lake dams.

Sincerely,

Glen J. McDonald

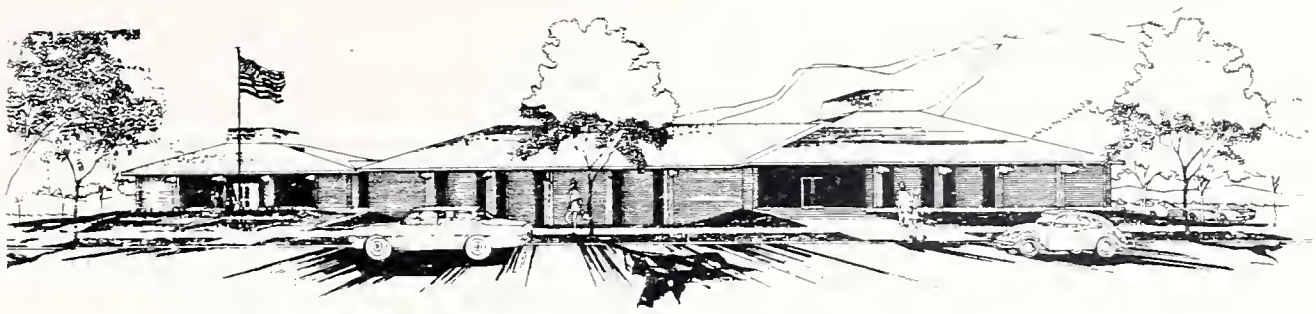
for Richard L. Bondy, Chief
Engineering Bureau

RLB:ADT/lh

COMMISSIONERS:
Box 846 Phone 778-2846
Delane Beach, Baker,
Chairman
Ray Lang, Plevna 59344
Art Koenig, Baker

CLERK & RECORDER:
Lee Dietz
Box 846 Phone 778-2846

COUNTY ATTORNEY:
Paul R. Young
Box 620 Phone 778-2406



FALLON COUNTY

BAKER, MONTANA 59313

ASSESSOR:
Curtis Huether
Box 499 Phone 778-2123

CLERK OF COURT:
Colleen Peck
Box M Phone 778-2114

SHERIFF:
Emil A. Hoem
Box 899 Phone 778-2814

SUPT. OF SCHOOLS:
Marlene A. Ferrel
Box 1117 Phone 778-2419

TREASURER:
Faye M. Koenig
Box 787 Phone 778-2132

April 24, 1979

Sidney Knutson, P.E.
Assistant Chief
Engineering Division
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Knutson:

On behalf of Fallon County I reviewed the Phase 1 Inspection Report for Upper and Lower Baker Dams. I found the following areas in need of attention:

page iii Upper Baker Dam is owned by Fallon County and operated by the City of Baker. Maintenance of the Lower Baker Dam is the responsibility of the State Highway Department.

... located on an unnamed tributary to Sandstone Creek.

page iv There should be documentation behind the statement "A sudden failure of Upper Baker Dam would endanger Lower Baker Dam and many lives and cause extensive property damage in the City of Baker." You fail to mention what properties lie within the hazard zone below the two dams.

page v Your statement that the dam is constructed of materials that will quickly erode is opinion. You have presented no substantiating data.

page vi Do seepage conditions exist? Later sections give contrary views.

page vii Your recommendation suggesting removal of the Lower Baker Dam in the event we fail to initiate corrective measures, shows a disregard for the importance of Baker Lake to the community. Your recommendations should have placed greater emphasis on measures and modifications that would alleviate the hazard potential.

page x Owner - Fallon County

page 2 Tom Eggensperger
Louis Jensen
Ken Pfeiffer

page 3 Upper Baker Dam is owned by Fallon County and operated by the City of Baker.

page 12 Your statement that "extreme property damage will occur before the dam overtops and there may be little increased damage as a result of dam failure", would be better applied to Lower Baker Dam. The Upper Baker Dam has a storage capacity of 1460 acre feet which would be released in the event of dam failure. The Lower Baker Dam has a capacity of only 320 acre feet, which would be relatively insignificant compared to the 5800 acre feet to be generated under your 'worst possible' conditions scenario.

page 14 In assessing the Lower Baker Dam abutments you failed to note that to the south of the dam the highway is very near or possibly lower in elevation to that of the dam crest. In the event of a dam overtopping this area may be where initial overtopping is most likely to occur.

page 19 The presence of pavement on the lower Baker Dam crest should have positive effect on dam stability.

In summary, the determination that both dams possess high downstream hazard potential should have included and been substantiated by where and what damage could be expected to occur. It appears to me that the damage would result more from the overflow channels inability to handle the extra flow and the subsequent flooding from its limited capacity.

Several references were made to the inability of the Lower Baker Dam spillway to handle the PMF. The recommendation advises and engineering study to determine the PMF and modify the project to safely handle the projected flow. There was no examination of the downstream channel situation. Perhaps this is outside the scope of the report. Unless the downstream channel is remodeled to handle the expected increased flows any dam modification short of providing total containment will do nothing to affect the downstream hazard potential. Additionally, the recommendation to breach the dam in the event that none of the recommended steps

are instigated, shows a disregard for the importance of the dam and Baker Lake to the community. Breachment of the dam could also increase the downstream hazard potential in the event of a minor storm of less magnitude than the PMF. Presently the dam provides some containment of runoff. With no containment at all, all runoff below the upper dam would enter the channel unimpeded and depending on the magnitude of the storm could cause considerable damage.

I suggest the report be modified to include an examination of the downstream channel and in the recommendations provide for a better solution than breachment of the dam.

I want to thank you for allowing us to review the inspection report and I hope my comments have not been too discouraging.

We would like to see the final edition of the inspection report before it is passed on to the Governor.

Sincerely,

Tom Eggensperger
Adminsitrative Assistant

TE/gfb

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124

14 MAY 1979

NPSEN-FM

Mr. Tom Eggensperger
County Planner
Fallon County
10 W. Fallon Avenue Box 1183
Baker, Montana 59313

Dear Mr. Eggensperger:

Our response to your letter dated 24 April 1979, concerning the Phase I Inspection Report of Upper and Lower Baker Dams, is as follows:

page iii Upper Baker Dam is owned by Fallon County and operated by the City of Baker. Maintenance of the Lower Baker Dam is the responsibility of the State Highway Department.

Response: Report corrected.

...located on an unnamed tributary to Sandstone Creek.

Response: Report corrected.

page iv There should be documentation behind the statement "A sudden failure of Upper Baker Dam would endanger Lower Baker Dam and many lives and cause extensive property damage in the City of Baker." You fail to mention what properties lie within the hazard zone below the two dams.

Response: Failure of the Upper dam would cause failure of the Lower Dam and lead to severe downstream consequences. Determining the exact nature of downstream damages is beyond the scope of this report.

page v Your statement that the dam is constructed of materials that will quickly erode is opinion. You have presented no substantiating data.

Response: The dam is constructed of very fine-grained material which offers little resistance to water erosion.

NPSEN-FM
Mr. Tom Eggensperger

page vi Do seepage conditions exist? Later sections give contrary views.

Response: No seepage was evident at time of inspection, however the pool at that time was 13.4 feet below top of dam.

page vii Your recommendation, suggesting removal of the Lower Baker Dam in the event we fail to initiate corrective measures, shows a disregard for the importance of Baker Lake to the community. Your recommendations should have placed greater emphasis on measures and modifications that would alleviate the hazard potential.

Response: We fully recognize and appreciate the importance of Lower Baker Dam and Lake to the community. However, the hydraulic-hydrology analysis clearly shows a discharge inadequacy which poses a threat to the dam's integrity. Our purpose in these inspections is to identify potential problems. We do not have funding or authority to pursue remedies. The most feasible and economic solutions to problems we find must come from more detailed study by competent engineers. This is properly a burden for the owners.

page x Owner - Fallon County.

Response: Report corrected.

page 2 Tom Eggensperger
Louis Jensen
Ken Pfeiffer

Response: Report corrected.

page 3 Upper Baker Dam is owned by Fallon County and operated by the City of Baker.

Response: Report corrected.

page 12 Your statement that "extreme property damage will occur before the dam overtops and there may be little increased damage as a result of dam failure." would be better applied to Lower Baker Dam. The Upper Baker Dam has a storage capacity of 1460 acre-feet which would be released in the event of dam failure. The Lower Baker Dam has a capacity of only 320 acre-feet, which would be relatively insignificant compared to the 5800 acre-feet to be generated under your "worst possible" conditions scenario.

Response: This sentence is being deleted from the report.

NPSEN-FM
Mr. Tom Eggensperger

page 14 In assessing the Lower Baker Dam abutments, you failed to note that to the south of the dam the highway is very near or possibly lower in elevation to that of the dam crest. In the event of a dam overtopping, this area may be where initial overtopping is most likely to occur.

Response: This was recognized but does not affect report findings that dam would fail.

page 19 The presence of pavement on the Lower Baker Dam crest should have positive effect on dam stability.

Response: While the pavement would tend to reduce erosion during overtopping, it would become undercut on the downstream side and would probably collapse within a short time.

Following is our response to your summary: A detailed downstream hydraulic analysis is beyond the scope of Phase I studies. The downstream hazard potential and projected results of PMF flows are based on engineering judgment. We agree the downstream channel is incapable of handling projected flows and have included a recommendation to study the downstream situation.

Sincerely yours,

John A. Poteat

JOHN A. POTEAT
Colonel, Corps of Engineers
District Engineer

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 970, Bozeman, Montana 59715

April 25, 1979

Mr. Sidney Knutson, PE
Assistant Chief, Engineering Division
Department of the Army
Seattle District Corps of Engineers
P. O. Box C-3755
Seattle, Washington 98124

Dear Mr. Knutson:

We appreciate the opportunity to make comments on the final draft of the Inspection Report on the Upper and Lower Baker Dams, Montana.

Page iii - 2nd paragraph, first sentence:
Sentence should read "Both Upper Baker and Lower Baker are embankment type dams, 20 and 17 feet high respectively, located on an unnamed tributary of Sandstone Creek."

Page vi - first paragraph, fifth sentence:
This sentence should read "Stability analysis by SCS was based on an assumed 6^0 shear angle and 400 pounds per square foot cohesion, and the resulting factor of safety was 1.4."

Page vii - RECOMMENDATIONS:
Would suggest in the first sentence that the word "immediately" be changed to "expeditiously." In the last sentence of RECOMMENDATIONS, again suggest that the word "immediately" be changed to "promptly."

Page 3 - Section 1.2.2 , first sentence:
The sentence should read "The Baker watershed is in the northern portion of the Great Plains Province near the center of a conspicious folded structure known as the Cedar Creek anticline."

Page 12 of report:
There appears to be a conflict between the last sentence of the second paragraph which reads "Extreme property damage will occur before the dam overtops and there may be little increased damage as a result of dam failure." and that stated on p. 19 second paragraph, last sentence, which states that "As Upper Baker Dam is constructed of materials that would erode rapidly should the dam overtop, its failure, with the subsequent failure of Lower Baker Dam, would cause extensive property damage and endanger many lives."

Page 15 - last paragraph, second sentence:
This sentence should read " The stability analysis was based on an assumed 6^0 shear angle, and 400 pounds per square foot of cohesion.

Incl 3

In summary, the findings and recommendations starting on page 20 of the report, raise the question on the adequacy of the embankment stability of the Upper Baker Dam. Reasons presented are concerns on the potential erodibility of the materials used in the embankment. The recommendations are that the embankment be modified to assure stability of the downstream slope and to provide a safety factor of at least 1./5. In reviewing our design criteria, SCS experience with the embankment materials used and their potential erodibility shows that an assumed 6° shear angle and 400 pounds per square foot cohesion, are very conservative.

Sincerely,

Van K Haderlie

Van K Haderlie
State Conservationist

cc:
Kenneth L Williams, Director, WTSC, Portland, OR
Stan Hobson, Head of Engineering, WTSC, Portland, OR
E. Lee Jones Area Conservationist, SCS, Miles City
Ken Peiffer, District Conservationist, SCS, Baker

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124

NPSEN-FM

10 MAY 1979

Mr. Van K. Haderlie
State Conservationist
United States Department of Agriculture
Soil Conservation Service
P.O. Box 970
Bozeman, Montana 59715

Dear Mr. Haderlie:

Our response to your letter dated 25 April 1979, concerning the final draft of the Inspection Report on Upper and Lower Baker Dams, is as follows:

Page iii - 2nd paragraph, first sentence:
Sentence should read "Both Upper Baker and Lower Baker are embankment-type dams, 20 and 17 feet high respectively, located on an unnamed tributary of Sandstone Creek."

Response: Report corrected.

Page vi - first paragraph, fifth sentence:
This sentence should read "Stability analysis by SCS was based on an assumed 6° shear angle and 400 pounds per square foot cohesion, and the resulting factor of safety was 1.4."

Response: Report corrected.

Page vii - RECOMMENDATIONS:

Would suggest in the first sentence that the word "immediately" be changed to "expeditiously." In the last sentence of RECOMMENDATIONS, again suggest that the word "immediately" be changed to "promptly."

Response: No change.

Page 3 - Section 1.2.2, first sentence:
The sentence should read "The Baker watershed is in the northern portion of the Great Plains Province near the center of a conspicuous folded structure known as the Cedar Creek anticline."

Response: Report corrected.

Sec. 4

NPSÆN-FM
Mr. Van K. Haderlie

Page 12 of report:
There appears to be a conflict between the last sentence of the second paragraph which reads "Extreme property damage will occur before the dam overtops and there may be little increased damage as a result of dam failure." and that stated on p. 19, second paragraph, last sentence, which states that "As Upper Baker Dam is constructed of materials that would erode rapidly should the dam overtop, its failure, with the subsequent failure of Lower Baker Dam, would cause extensive property damage and endanger many lives."

Response: Sentence deleted.

Page 15 - last paragraph, second sentence:
This sentence should read "The stability analysis was based on an assumed 6° shear angle, and 400 pounds per square foot of cohesion."

Response: Report corrected.

In response to your summary, our reply is as follows. Our stated concerns regarding embankment erodability and stability of the downstream slope are separate, non-related issues. Erodability is of concern because the dam is constructed of fine-grained materials which, in our opinion, would be rapidly eroded under conditions of significant overtopping.

Stability of the downstream slope is of concern because of type of embankment materials, steepness of the slope, and lack of interior drainage provisions. Also, we are unaware of any technical basis for using the assumed strength values in the stability analysis. In our opinion, stability analyses of a potentially hazardous structure, constructed of clayey materials on a clay shale foundation, should be based upon conservative strength data obtained from appropriate laboratory testing, and not on assumed values. If the SCS has conducted laboratory strength testing of the embankment and foundation materials, we would appreciate receiving this information.

Sincerely yours,

MAXEY B. CARPENTER, JR.
Lt. Colonel, Corps of Engineers
Deputy District Engineer

TABLE 10

UNSAFE DAM
NATIONAL PROGRAM OF INSPECTION OF DAMS

a. NAME Lower Baker Dam

b. ID NO.: MT-1263

c. LOCATION: State: Montana County: Fallon

River or Stream: Sandstone Creek

Nearest D/S City or Town: Baker, Montana

d. HEIGHT: 17 feet

e. MAXIMUM IMPOUNDMENT CAPACITY: 1100 AF

f. TYPE: Earth

g. OWNER: Fallon County

h. DATE GOVERNOR NOTIFIED OF UNSAFE CONDITIONS: 22 June 1979

i. CONDITION OF DAM RESULTING IN UNSAFE ASSESSMEN
The spillway will handle less than 15% of the estimated PMF, and as a result, Lower Baker Dam will overtop during floods considerably smaller than the PMF. The dam is constructed of materi that will quickly erode and will rapidly fail overtopped by floodwaters.

l. URGENCY CATEGORY: Non-emergency

m. EMERGENCY ACTIONS TAKEN: N/A

n. REMEDIAL ACTIONS TAKEN BY OWNER:

j. DESCRIPTION OF DANGER INVOLVED: The downstream hazard potential is classed as high (No. 1). Sudden breach would endanger many lives and caus extensive property damage in the City of Baker.

k. RECOMMEDATIONS GIVEN TO GOVERNOR: 1. Immediat develop and implement an emergency warning plan for use in the event of dam overtopping. 2. Re pair the undercut section of the spillway. (For further recommendations, see attached shee

o. REMARKS:
An upstream dam, Upper Baker Dam (MT-1564) may not conform to guidelines with respect to spillay capacity to handle the PMF or stability of the downstream slope. Recommendations are made in the report to re-examine embankment stability.

k. RECOMMENDATIONS GIVEN TO GOVERNOR (Continued)

3. Remove trees growing on upstream slope and using suitable backfill, repair holes left by removal of stumps and roots.

4. Remove the earth berm obstructing the spillway approach channel.

5. Install piezometers in the dam, and evaluate the phreatic surface and its effect on embankment stability.

6. Conduct an engineering study to determine the probable maximum flood (PMF), and modify the project to safely handle the full PMF. The PMF study should include an independent check of the SCS Upper Baker flood study and an assessment of downstream channel capacity and possible methods of handling the projected flows.

7. Should the engineering studies and the required modifications be delayed or impossible to accomplish, the lower dam should be removed.